

# Remote Sensing of the Self-Organizing Systems by Dark Pulse

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**Abstract**-The new approach is based on the use of the low power radiation constant source as the sounding element having the interval of the radiation interruption (dark pulse) for a while commensurable with time of radiation and usual lidar systems. The following is used: the special time organization of an entering coming signal digitization, when registration time in each readout is commensurable in due course passages by a signal of all zone of measurements is beside; restoration of the environment characteristics with the necessary permission is reached by special processing of the received readout of the signal taken in pairs and differing on time of digitization on the interval corresponding of such permission; identification of the structure of the inhomogeneities is decided by a special method of structural and statistical analysis; identification of anomalies in the structure is decided by a special method of nonlinear filtering.

**Keywords**- Remote Sensing; Lidar System; Signal Processing; Self-Organising System; Unstability; Air Tsunami

## I. INTRODUCTION

Purpose of the offered approach consists in development of the dynamic analysis remote methods of great volumes from self-organizing systems, for example, atmosphere, when similar systems lose the stability or pass from one status of stability to another. Because of nonlinear character of proceeding processes and complexity of similar systems, the highly specialized traditional approaches which are not considered behavior of such systems as a single whole, are not effective.

Development of the new approach for remote measurements and modeling of the self-organizing processes in unstable systems becomes more and more practical. However, it is impossible to provide effective security measurements for the environment and the population using modern costly pulsed lidar system. The following summarizes the research results and further analysis carried out since 1985.

## II. ACTION

Processing received one-dimensional noise-similar remote signal (know how), which is offered to bear the information on developments of the complex structure heterogeneities in the earth's atmosphere as a self-organizing system. Identification of trends and development of such structures, with the simultaneous analysis of the thermodynamic stability of the environment allows us to introduce a generic measure that allows the prediction of the

possible processes of restructuring of the environment and to identify the signs of the development process of a catastrophic scenario. One example of such a scenario is given below, as a model can be processes such as tsunami waves in the surface atmosphere (Fig. 1).

A classic example of such processes in the atmosphere is the emergence and development of internal waves<sup>[1]</sup>. The stable stratification of the atmosphere is a prerequisite for the emergence and development of such waves from small disturbances<sup>[2]</sup>. The accumulation process (unidirectional wind-shear and presence of particulate pollution) may lead to instability or overturning of the waves<sup>[3]</sup>. Further development of the wave process of a catastrophic scenario could even lead to the appearance a tornado<sup>[4]</sup>.



Fig. 1 Tsunami waves in the surface atmosphere

### III. ADVANTAGES

Several solutions for remote sensing systems and such self-organization processes can provide the following advantages:

- Essential increase of the measurement accuracy of the returning signal, by use of strobes of registration or impulses of probing radiation commensurable with extent of a zone of measurements <sup>[5, 6]</sup> (Fig. 2).

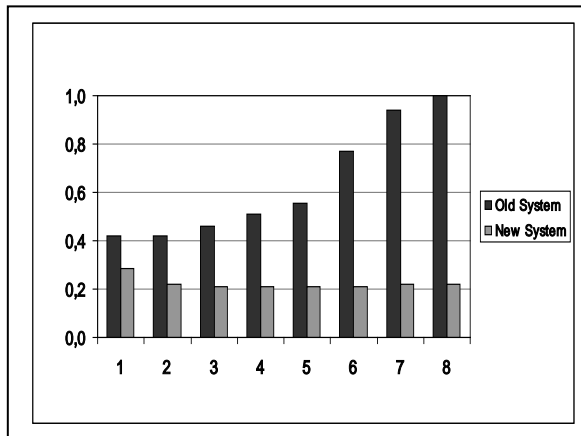


Fig. 2 Considerable increase in the measurement accuracy of an incoming signal using strobes of registration or impulses of probing radiation commensurable with the extent of the measuring zone

- Essential reduction of energy of radiation of a probing source is necessary for reception of the demanded relation as a signal/noise and decrease in a dynamic range of a registered signal on several usages depending on conditions in environment (Fig. 3).

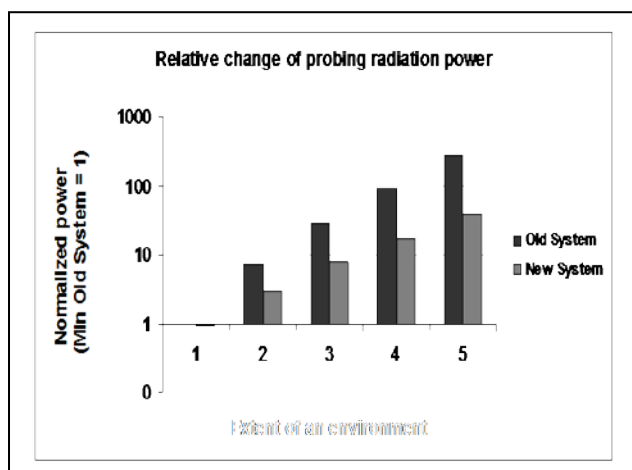


Fig. 3 Considerable reduction in the radiation of the probing source necessary for the required signal-to-noise ratio

- It needs restoration of characteristics of environment on the received signal with the necessary permission, by use of pairs of readouts of a signal from sites of environment with one general border and differing on a demanded step of the permission (Fig. 4).

- Reveal signs of a regularity of the generalized horizontal structure environments by the special structurally-statistical analysis <sup>[7, 8]</sup>, taking into account vertical

thermodynamic stability of environment by the generalized criterion, which is received on the basis of a complex of thermodynamic parameters <sup>[9]</sup> (Fig. 5).

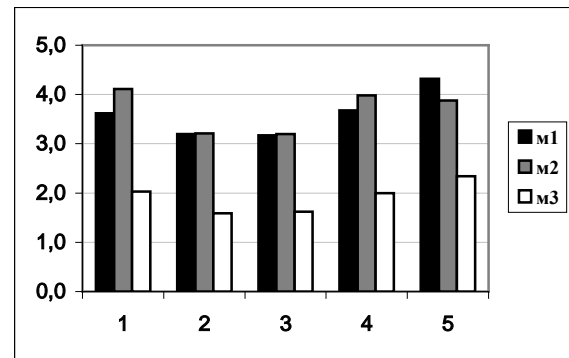


Fig. 4 Results of the interval definition between elements of the generalized structure of different type ( $M^1$ ,  $M^2$ ,  $M^3$ ) for optical regular

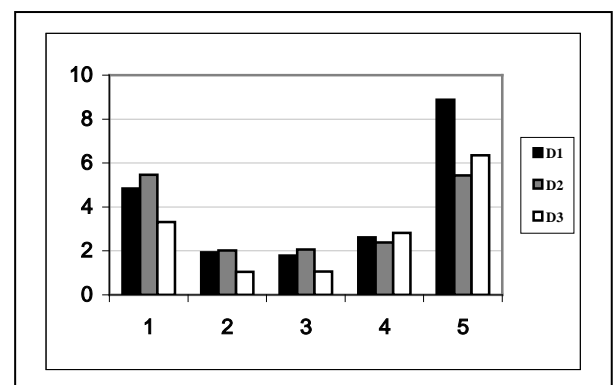


Fig. 5 Results of the dispersion definition between elements of the generalized structure of different type ( $D1$ ,  $D2$ ,  $D3$ ) for optical regular inhomogeneities of five atmospheres chosen areas

- Reveal signs (predictors) infringements of instability of structure and its reorganization, by detection of local anomalies from a special nonlinear filtration (GRAN) <sup>[10]</sup> (Fig. 6).

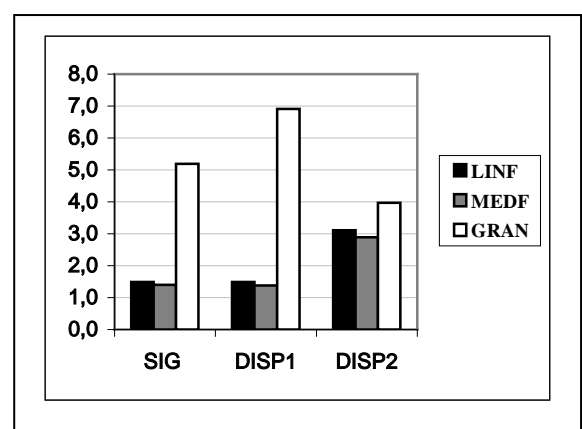


Fig. 6 Results of comparison of offered processing of the coming signal dispersion (a nonlinear filtration - GRAN) with methods linear and median filtrations (LINF, MEDF)

### IV. CONCLUSION

In the first two items, accuracy of measurements of a signal raises on an extreme measure 10 times. It allows

spending demanded measurements of the heterogeneities in conditions of essentially big background noise.

We receive essential shift towards a smaller dynamic range of a registered signal. The bigger relation of a signal/noise is, the smaller error of measurements is, the smaller energy of radiation of a probing source is. The set relation of a signal/noise in a wide range of external conditions is provided.

In the following items, regular generalized horizontal structure of the heterogeneities in atmospheres is found out in a ground layer of an anticyclone. Long-wave of a component arises at reduction of vertical thermodynamic stability of atmosphere.

There is a possibility of the forecast of infringement of vertical thermodynamic stability of environment on character to its horizontal structure of the heterogeneities. This requires a network of lidar stations (network-based weather stations) on the basis of the proposed approach with the use of low-power laser pulses. The logic of this approach<sup>[6]</sup> makes it possible to go to the dark environment sensing pulses of radiation sources as described in the article<sup>[11]</sup>.

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Polkanov Y.A. Looking at Remote Sensing the Timing of an Organization's Point of View and the Anticipation of Today's Problems. *Remote Sensing of Planet Earth* ISBN 978-953-307-919-6 Edited by: Yann Chemin Publisher: InTech/27/01/ 2012.

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2007 Proceedings Vol. 6684 Atmospheric and Environmental  
Remote Sensing Data Processing and Utilization III: Readiness for  
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Philip E. Ardanuy, Editors, 66841I Date: 13 September 2007  
ISBN: 9780819468321  
[http://spie.org/x648.html?product\\_id=738735](http://spie.org/x648.html?product_id=738735)

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